THE HISTORY OF THE BRITISH COAL MEASURES:

Being an Account of the Range and Distribution of the Coal Formations beneath the more Recent Strata of the Central and Southern Counties of England.—No. II.

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The most conspicuous uprising of these beds in the heart of England is in Charnwood Forest, Leicestershire. The Cambrian rocks are here brought up on the east of the coal field by a fault, but this only hastens their natural appearance, as forming the original margin of the coal measures in that direction. There are several other spots farther to the east where bosses of trap, apparently of the age of the Charnwood Forest rocks, reach the surface through the red marls of the Trias, indicating the total absence of the coal measures. From these points, if we trace the boundaries of the coal fields of the Midland Counties through Warwickshire, South Staffordshire, Worcestershire, and Shropshire into North Wales, we shall find frequent evidences of the proximity or actual appearance of a ridge or barrier of land which, I believe, formed the margin of the Carboniferous area across the centre of England. Space will not admit of detailed reference to each of the spots where the old rocks reach the surface. They occur near Atherstone, west of Birmingham, and at the Licky Ridge, north of Bromsgrove. In these spots the rocks are of Cambro-Silurian age. In Shropshire, however, as at Bridgenorth, the Devonian formation appears, having originally formed in some places the margin of the Carboniferous area. The Silurian rocks, however, predominate, and furnish the margin at Wellington, Shrewsbury, and along the banks of the Severn into North Wales. The spots here indicated do not lie in a regularly curved line, but as it were in a series of promontories jutting northward from the main land, which we may call "The Barrier." The northern margin appears to have been irregular in outline, frequently indented with bays, in which tracts of coal measures were formed, such as the coal fields of the Forest of Wyre and of Warwickshire. In some places only the very uppermost beds were formed, the land not having been submerged till towards the close of the period. This barrier of land is shown on the map as crossing the centre of England in a narrow and indented band.

The southern margin of The Barrier can only be very roughly determined. The northern limits of the great coal tract of South Wales must have extended far beyond its present bounds, and the same may be said in a lesser degree of the coal fields of the Forest of Dean and Somersetshire. It is, therefore, probable the greater part of the slaty region of South Wales was once covered by beds of coal, and that along the Valley of the Severn The Barrier was extremely narrow at the close of the Carboniferous period. Mr. Godwin-Austen has shown the probability that a band of coal measures originally stretched across the South of England from Somersetshire into France and Belgium. That this band did not stretch far to the north of the estuary of the Thames there is reason for concluding, from the results of the boring experiments at Harwich. Here cleaved slaty rock of Silurian or Cambrian age was reached beneath the Cretaceous beds, without a trace of the intervening formations. We may well believe that this slaty rock forms but a part of the tract of ancient land which stretches under the Eastern Counties, and of which the rocks of Charnwood Forest formed the margin towards the north-west.

From the above observations it will be seen that the coal measures of England formed originally two separate areas, one lying to the north, the other to the south, of The Barrier, as indicated in the map. These have subsequently been broken up and formed into separate "coal fields," which may be thus arranged:—

Coal Fields North of The Barrier.—North Wales, Forest of Wyre, North Staffordshire, South Staffordshire, Warwickshire, Leicestershire, Derbyshire, and Yorkshire, Northumberland, Durham, and Cumberland.

Coal Fields South of The Barrier.—South Wales, Somersetshire, Forest of Dean, and supposed band along the Thames Valley.

The coal fields of the central valley of Scotland were, probably, connected with those of the North of England, round the eastern coast, but space does not admit of further reference to them on this occasion.

2. *The Distribution of the Carboniferous Strata themselves.*

There are three main causes tending to increase or lessen the thickness of any group of strata at special points of its area during deposition. First, the sediment may be deposited over a deep-sea bed, or a shelving shore; secondly, the sediment deposited may be near or at a distance from the source of supply; and thirdly, the velocity of the current may be great or small, the transporting power of which is as the sixth power of the velocity. Observations on the accumulated thickness of strata or groups are instructive, as tending to throw light on these questions, but the subject regarded in this light has not received its due share of attention. Classifying the strata which compose the Carboniferous group into Calcareous and Sedimentary,* and confining our attention to the latter, we can compare the relative thickness of these beds with their representatives in various parts of the country, and in so doing arrive at some very interesting results, for we find the thickness changing according to a definite plan of arrangement. On the north side of The Barrier we find a constant diminution in the vertical thickness of the gronp on proceeding from north to south; while on the south side of The Barrier the decrease takes place from west to east, showing a change of physical conditions, and the marked influence which this dividing ridge has exerted upon the distribution of the sedimenatry materials.† Supposing the velocity of the currents which have transported the sands and clays of the coal measures to have been the same on both sides of the Barrier, we may conclude that thinning of the beds arises from the two first causes above stated—the approach to a shelving shore, and the diminishing supply of sediment as the distance from the sources of supply increases. It would, therefore, appear that north of The Barrier the source of supply lay to the north, and south of The Barrier the source lay to the westward. These sources must have been lands traversed by rivers bringing down sand and mud, which the currents of the sea took up and distributed over the ocean bed.‡

As illustrations of the thinning away of the beds on either side of The Barrier from north to south in one case, and from west to east in the other, let us take the following from districts lying in nearly direct lines in each case, which have been very carefully measured during the progress of the Geological Survey:—

NORTH OF THE BARRIER.

	Lancashire.	North Stafford.	Leicestershire.
Upper coal measures	2000	1000	
Middle ditto	3500	4000	2000
Lower ditto	1800	1000	1000
Millstone grit	3500	500	50
Yoredale beds	2000	2300	50
Total	12,800 feet.	8800 feet.	3100 feet.

SOUTH OF THE BARRIER.

	Glamorganshire.	Forest of Dean, Gloucestershire.
Coal measures	11,650	2765
Millstone grit	330	455
Total	11,980 feet.	3210 feet.

From the above examples it will be observed that between Lancashire and Leicestershire there is a falling off, in a distance of about 70 miles, of about 10,000 feet of strata, and between Glamorganshire and Gloucestershire, in a distance of about 50 miles, a falling off of about 8000 ft. Similar results might be obtained by comparisons along parallel lines of country.

The question may now be asked, "What does this prove?" The answer, I think, is plain; it proves the gradual dying out of the coal formation towards the Eastern Counties, and affords grounds for the belief that even if there had existed no barrier of land in this part of England, the formation would have failed to extend itself under the Cretaceous districts. The Barrier has, however, formed the termination of the northern coal area towards the south-east, as well as of the southern coal area towards the north-east, in both instances more abruptly than would have resulted from the mere thinning out of the beds; on these grounds I have left unshaded the part of the map forming the Eastern Counties.‖

3. *The Distribution of the Formations overlying the Carboniferous.*

We now approach the third topic of our enquiry, and in doing so shall limit ourselves to the Permian, Triassic,§ and Jurassic¶ formations. The lowest member of the Permian formation (the *Rothe-todtliegende*) is extremely variable, and seems to have been deposited in a depression formed in the carboniferous beds of which Warwickshire may be considered the centre. Here it reaches a thickness of 2000 feet, and thins away from this centre in every direction. The upper member, or magnesian limestone, is for the most part confined to the north-east of England. Coal may be considered as within workable reach whenever it occurs under the Permian formation, provided this latter forms the surface of the ground, and the depth will not exceed 1000 yards.

When we come, however, to consider the distribution of the formations which succeed the Permian, we cannot but be struck with the regularity of the plan upon which they have been formed. We have already seen the manner in which the carboniferous strata increase and decrease in certain directions. Now, it has been found, in comparing a series of carefully-measured sections, and tracing the subdivisions of the Triassic group, that they undergo a like decrease in thickness from the north-west towards the south-east of England, so that a series of lines, each representing a certain thickness of beds wherever drawn, would be found to cross the country obliquely from south-west to north-east.* The Trias attains its greatest vertical development in Lancashire, and from this gradually thins away towards Warwickshire, so that while in the former county the thickness may be placed at nearly 5000 feet, in the latter it is only 600 where it passes below the lias. Here we lose all sight of it, but, judging from analogy, we may conclude that it thins away altogether somewhere about the line of the chalk escarpment; and we know from actual experiments that it does not reach the sea at Harwich.

By a series of similar comparisons, we find that the Lias undergoes a similar change in thickness, dying off towards the south-east; and there is reason to believe that the succeeding clayey beds of the oolitic groups prove no exception to the rule. Now, as these formations, owing to denudation,† terminate abruptly in the direction of their maximum of thickness—in other words, towards the north-west—we may regard them as a series of great wedges lying over each other in succession, with their thin edges directed towards the south-east coast, but never actually reaching so far.

The view here adopted of the close proximity of the ancient Cambro-Silurian rocks beneath the Cretaceous in the south-east of England, receives confirmation from certain characteristics of this latter group itself. Conglomerates, consisting of black hornstone, slate, and quartz, are not uncommon; and in the notable sinking made in search of water at Kentish-town, near London, a conglomerate of syenite, greenstone, porphyry, quartz, and schistose pebbles was reached at a depth of 1122 feet from the surface. These pebbles being the *detritus* of subaërial rocks in the neighbourhood of the strata which were being formed over the bed of the sea at the commencement of the Cretaceous period, seem to indicate the total absence of the softer strata of the latter Palæozoic and earlier Mesozoic periods.

4. *The Mutual Relationship of these Formations, and their Teachings.*

From the above considerations it will be apparent that while the coal formation attained its greatest development in the North of England, the formations which overlie it also attained their greatest vertical dimensions in nearly the same direction; and since the coal measures are brought to the surface in Lancashire, Staffordshire, and North Wales, it follows that the elevating forces and the agencies of denudation have acted with greatest effect over these parts—that is to say, *looking at the beneficial results*, where most needed. How impenetrable would have been the covering which once overspread the coal measures of the north-west of England may be judged by estimating the thickness of the strata which we may infer formerly covered the Lancashire coal field to a depth of 7000 feet, distributed as follows:—

Jurassic strata	1600
Triassic strata	4750
Permian strata	650=7000 feet.

This enormous amount of material which buried the precious deposits of mineral fuel has been swept away, and the north-western coal fields have been brought to light. In the central counties little more than half this amount needed removal in order to disclose the coal fields of those districts; further east the amount was still less, but *there* we approach the margin of the original coal tract itself. We arrive, therefore, at this conclusion—that Nature put forth her greatest efforts when there was work to be done for a certain beneficial end; in other words, the utilisation of the mineral fuel which had been stored up for countless ages beforehand.

Now let us for a moment reverse the picture. We can easily conceive the elevating forces which have upheaved the formations towards the north-west, acting in such a manner as to have upheaved the formations from the south-east. As far as we can see, there is no physical cause why the one should have taken place in preference to the other. In such a case what would have been the result as regards ourselves, our commerce, our position as a nation? It has been shown with a certainty only short of demonstration that there is no coal under the Eastern Counties, and that the coal of the Western has once been placed at inaccessible depths by enormous accumulations of more recent strata. If, therefore, the upheaval and denudation had taken place from the south-east, it is perfectly clear that the coal fields of the North-West and Central Counties would have remained buried at unapproachable depths; and in the East of England a region composed of granitoid or slaty rocks would have been brought to light; in a word, we should have had a region in Suffolk such as North Wales, and one resembling Cambridgeshire in Lancashire.

But we cannot shut our eyes to the fact that however large the areas of coal which Providence has placed within our reach, still larger areas are concealed to view, and an extent of coal ground equalling the whole of that now remaining, whether at the surface or below it, has been entirely swept away. If we compare the extent of the original coal formation with the actual coal areas, we shall be struck with this fact. Nature in this case, while operating for the future benefit of the patient, has not neglected to make use of the knife; but as it is better for a patient to lose a limb in order to save his life, so we have no right to complain if our present extent of coal surface has been secured at the sacrifice of even a large part of the original area.—*Quarterly Journal of Science.*

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* That is, limestones on the one hand, and sandstones, clays, shales, &c., on the other.

† I take for granted that all my readers admit that the sedimentary strata have been deposited from sands, mud, &c., held in suspension by the sea and carried by currents.

‡ The depth of shading on the map will indicate what may be considered the deep and shallow parts of the submerged areas.

‖ I may again refer to the Harwich boring, which, in a remarkable degree, corroborates the above inferences.

§ *Triassic*—comprehending new red sandstone and marl.

¶ *Jurassic*—those of the lias and colite.

* Such lines I have traced for the Carboniferous group under the term "isometric lines." See "Quarterly Journal Geological Society," vol. xviii., p. 127.

† "Denudation" is a term used to express the sweeping away by the sea, rivers, &c., of portions of the strata.

THE GAS AND CANNEL COAL TRADE.

An influential meeting of coalmasters interested in the working and sale of Parrot and Cannel Coal has been held, and the result is an advance of 12½ per cent. on all descriptions. There was a large attendance of parties from the various districts connected with the trade, the proprietors or representatives of the following collieries being present:—Arniston, Newbattle, Niddrie, Bo'ness, Overton, the several Wilsontown collieries, the Parrot coal proprietors of the Baillieston, Motherwell, and Dalserf districts, the Lesmahagow, and the Douglas Gas Coalworks, and the Gas Coal works of Ayrshire. Letters intimating willingness to co-operate were read from Wemyss and Preston Grange Collieries. Mr. J. Ferguson (of Auchenheath), occupied the chair, and stated that while he approved of the meeting, he had no credit for getting it up. The meeting then fully discussed the question of a general advance on present prices, and having very fully considered the matter, and heard the report of parties as to the advance that had taken place during the last three years on the cost of raising, the increase of capital necessary for carrying on the trade, and the increased demand—while during this period the selling price had either remained stationary or declined—it was unanimously resolved that a uniform advance of 12½ per cent should be made on all descriptions of Parrot and Cannel coal, taking effect from and after January 1. The subjoined is an approximate of the annual output and present stock of Parrot and Cannel coal:—

Name of district.	Estimated annual output.	Estimated stock on hand.
Lanarkshire	Tons 172,000	Tons 36,500
Linlithgowshire	28,000	—
East and Mid Lothian	55,000	10,000
Fifeshire	29,000	10,000
Ayrshire	38,000	5,000
Total	Tons 322,000	61,500

The estimated output in 1846 was 150,000 tons. The estimate was prepared from information furnished by those present, and from this statement it would appear that the stock on hand is about a fifth of the annual output. Contracts affecting this output were reported for other purposes than gas-making, to the extent of about 250,000 tons.

"About Railways."—With those who desire to read only that which is useful, the name of the publisher of a work is generally regarded as of fully equal importance to that of the author, and for reliable facts in the most popular style, "Chambers, London and Edinburgh," is always an ample guarantee. In his book "About Railways," Mr. William Chambers, of Glenormiston, has been careful that the reputation of the firm shall not suffer from its publication, the work being undoubtedly one of the most instructive and interesting that could be desired. Although occupying no more than a hundred pages, Mr. Chambers has treated, and, considered from a popular point of view, exhaustively treated, of the legislation and management of railways, their construction, rolling-stock, and traffic; railway tickets, the railway clearing-house, railway links in the metropolis, railway station hotels, and curious railway undertakings; as well as giving some interesting statistics; some valuable suggestions on cheap railways; and a glance at foreign and colonial railways. The book is admirably adapted for railway passengers, and will remove the monotony from many an otherwise tedious journey; whilst to the nervous, the statistical portion will prove a more effective dose than anything which the most experienced physician could prescribe, for it will tell him that railways are so well and safely managed that, although in the course of a single year no less than 205,000,000 passengers are carried, only 13 lose their lives, and but 400 receive personal injury throughout the entire of the United Kingdom.

"Self Help."—Under this title, Mr. Samuel Hill, of Wolverhampton, has just issued, in pamphlet form, a concise little essay, originally prepared as a paper for delivery before the South Staffordshire Adult Educational Association, and dedicated to the present Lord Lyttleton. Mr. Hill urges that everyone's motto should be—"Let it be your glory to do your duty," and that whilst it is undesirable that all should be centred in oneself, but that a certain degree of self-help and self-esteem dignifies its possessor. In confirmation of his views, he quotes various authorities from the time of the Creation until the publication of the Autobiographies of Smiles, and, as personifications of his idea as to the mode in which the two qualities should be combined, he alluded to Alfred the Great and Cardinal Wolsey directly, and to Bagnall, Barker, Foster, Hall, Jones, Sparrow, Thorneycroft and Williams incidentally. The pamphlet is one which should be carefully studied.

Petroleum Gas.—A simple and effective process of making gas from crude coal oil is already in use in America. The entire apparatus is but a miniature of the works of an ordinary gas company, with pipes, condensers, retorts, furnace, gasometers, and all—all except the appliances necessary to desulphurise the coal, nature having accomplished this part of the business in forming the petroleum. It is claimed that 200 ft. of gas is easily made from 1 gallon of oil, and that the light is superior to that obtained in the old way. The economy of the improvement certainly presents strong inducements to test its utility, as a saving of at least 50 per cent. is confidently promised.

Improvements in Feeding Blast-furnaces.—A mode of feeding blast-furnaces, which appears likely to give great satisfaction, has been introduced by Mr. W. Barningham, of Darlington. A line of rails is fixed on the top of the blast-furnaces, along which the locomotive and wagons pass, and the wagons can, therefore, be emptied into the mouth of the furnaces. The advantages of the plan are that the saving compared with the old plan is immense, for it should be considered that to supply 20 furnaces for 12 months, making 400 tons of pig-iron per furnace per week, equal to (say) 400,000 tons per annum, would require a man to travel with a barrow a distance altogether equal to about 300,000 miles before the requisite quantity (say 2,000,000 tons) of material entered the furnaces, besides having to wheel the same distance a weight equal to about 1,600,000 tons, being dead weight for barrows. The immense waste of labour in having to pick up with shovels and forks 2,000,000 tons of material, and then wheel it in barrows to the hoists, is apparent at a glance, and clearly shows the necessity of the plan here proposed, which will discharge the wagons wholesale into the furnace mouths, entirely dispensing with pneumatic, hydraulic, steam, or rope incline hoists; also depôts and depôt hoists, which lift the material a considerable height and then drop it down again, doing great damage to the coke, which must afterwards be picked up with shovel and fork by hand labour. The new plan also dispenses with shovels and forks, bankers, scopes, and barrows, as well as with barrow fillers and wheelers.

Rolling and Hammering Iron.—According to the invention of Mr. J. Ramsbottom, of Crewe, he proposes, as an improvement in rolling machinery, to substitute a friction or shearing apparatus for the "breaking spindle" usually employed for connecting the driving power to rolling-mills. His improvements in hammering consists in mounting his duplex hammer, already described in the Journal, upon toothed sectors instead of wheels.

Improved Safety Gunpowder.—As an improvement upon his patent of October, 1864, Mr. L. H. G. Ehrhardt, of Bayswater, proposes the use of tannin, or such substances as contain this material in large proportions, such as cachecu gum kino, coal, mineral, or vegetable carbon, &c., in combination with either chlorate of potash or other fusible chlorates, or nitrate of potash singly or in combination. The proportions of the above ingredients will vary according to the effect desired; thus, a good blasting powder may be made by using—1. Chlorate of potash, 1¼ part; nitrate of potash, 1¼ part.—2. Cutch, one part; cannel coal, two parts, all by bulk. The whole of the materials are finely powdered—the two compounds are kept separate until required for use, and are then thoroughly incorporated. For military and sporting gunpowder he employs chlorate of potash, four parts; tannin or cutch, one part by weight: the whole finally powdered. For explosive shells and similar projectiles, chlorate of potash, six parts; tannin or cutch, one part. Whilst the compounds are separate they are inexplosive.

Anti-friction Centrifugal Pump.—The principles upon which the centrifugal pump is constructed is already well known, but the improvement recently introduced by Mr. W. D. Andrews, of New York, will, it is claimed, render it of far greater practical utility. From a careful study of the law upon which the centrifugal pump is constructed, and the consideration of the fact that sudden changes of motion consume power, Mr. Andrews was led to the idea so to construct his pump that a continuous supply of water is conducted to the rotating disc, having wings projecting from its surface, and by means of spiral passages is delivered to it in the line of its motion, and in escaping from the wheel is by means of the spiral delivery passage again, by an easy and gentle curve, brought back to a straight line when it emerges from the pump. No sudden change is given to the current at any portion of its course, but by the peculiar construction the water, entering the pump at right angles by the motion of the rotating disc, is by long spiral passages turned from its direct forward course and delivered to the disc in the line of its motion. The disc is a truncated cone, considerably smaller than the case within which it revolves, but having wings upon its periphery, extending across and sweeping the space between it and the case. When the disc is set in motion, the water upon its surface and between the wings has a tendency to fly off in a tangential line (as before explained), but meeting in its course an inclined circular surface it is again changed, by an easy spiral, back to a straight line at right angles to its entrance into the pump, when it leaves at the discharge orifice. The wings run close to, but do not touch the case, and the only part in contact to create friction is the shaft in its bearings. The result is, that the machine itself being almost without friction, and the water pressing through the pump without sudden change of motion, a large proportion of the power is saved which is lost by a different construction.

Substitute for Magnesium.—Science has discovered, through the skill of a French chemist, a new substitute for the new metal magnesium, which will produce a light nearly as brilliant, at a very much lower cost. The new light is produced by the combustion of a mixture of twenty-four parts of well-dried pulverised nitrate of potash, with seven parts of flowers of sulphur and six of the red sulphide of arsenic, and the mixture can be sold at about 3d. a pound. Professor Tyndall has been exhibiting at the Royal Institution some more of the marvellous phenomena of the connection of light and sound. The experiments have been original, often absolutely new, and when the effect of the vibration of a tuning fork was clearly shown by the fluctuations of light the effect was most striking. What these "co-relations" will lead to a century hence fancy fails to paint!

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